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THE CARBONIFEROUS QUADRUPEDS.

THOSE OF KANSAS, OHIO, ILLINOIS, AND PENNSYLVANIA IN THEIR RELATION TO THE CLASSIFICATION OF THE SO-CALLED AMPHIBIA AND STEGOCEPHALA.

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THE earliest quadrupeds known, as diverged into distinct types, have been called the amphibian and the reptilian. It is often difficult, if not at times impossible, to draw the line between these two large groups of animals. Before men had gone deeply into the study of paleontology these two groups were considered small and unimportant, but now that we know more than two dozen orders of reptiles, mostly extinct, and some nine orders have been assigned to the Amphibia, that opinion is no longer held, and we realize that the amphibians and the reptiles were dominant on the earth, among vertebrates, in late Palæozoic and throughout the entire period of the Mesozoic. Just what constitutes a reptile and an amphibian no one is so bold as to state at the present day, but we are warranted in making suggestions as to what seems right in the light of our present knowledge. On this basis we will assume the right of discussing the classification of one of these large groups—the one usually known as the Amphibia—which we shall see is a most heterogeneous assemblage.

The Carboniferous rocks of Kansas, Ohio, Illinois and Pennsylvania—and I doubt not those of West Virginia, Iowa and Indiana will also be found to contain them—contain the remains of vertebrates which are of a higher type than the fishes. The remains as they are preserved to us usually represent small creatures, although we occasionally find fragments which show that larger individuals existed at this time also. We will cite as instances of this the two large vertebræ named by Professor Marsh as belonging to *Eosaurus acadianus*, and a large rib to be described by the writer, a portion of a large skull designated elsewhere by the writer as *Macrerpeton huxleyi* Cope (formerly described as *Tuditonus huxleyi* Cope), and various fragments recently described by Case as pertaining to an unknown species of *Eryops*; as well as the large fragment of a tooth which Williston described in 1897 from near Louisville of this state. He was able to show from the microscopic structure of the tooth that the form was an undoubted labyrinthodont, which he allied with *Mastodonsaurus*.

The localities in the various states under discussion in which these early quadrupeds have been found are, in Kansas, Louisville and near Winfield; in Ohio, the famous Linton mines; in Illinois, the Mazon Creek beds; in Pennsylvania, Cannelton and Pittsburg. Three other states of the Union have furnished other remains, but they are not worthy of mention in this connection. Nor are the footprints discovered and partially described by Professor Mudge from Kansas, and by Lea and King from Pennsylvania, of sufficient diagnostic value to warrant consideration here. Since the creatures from the Mazon Creek beds in Illinois and the Linton, Ohio, mines have furnished the most complete material, we will confine our discussion in large part to them.

Among the several hundred specimens of the early quadrupeds collected by Dr. J. S. Newberry at the Linton mines, none is perhaps more remarkable than the one first described by Doctor Wyman in 1858 as *Raniceps (Pelion) lyelli*. Doctor Wyman and, later, Professor Cope, who studied the same specimen, called attention to the decided frog-like aspect of the skull, and indeed the comparison is a very striking one. It is barely possible that this species (plate I) may represent a form of the ancestral group from which our modern frogs have descended, although we have no direct evidence on this subject, since the form of the present specimen is preserved merely as a mold in the soft coal. There is present in the specimen a portion of the right hind limb, which is strikingly frog-like, and this tends to strengthen the suggestion of the skull as to the anuran nature of the species. The vertebral column is, however, quite long; entirely too long for the frogs as we know them. The writer has in mind some embryological investigations which ought to go a long way toward settling this question, and he hopes to present a discussion of his results elsewhere. If *Pelion lyelli* Wyman is not related to the early ancestors of the frogs then we have not the slightest evidence of frogs or frog-like animals prior to the Eocene. The form named by Marsh *Eobatrachus agilis* from the Lower Cretaceous of Wyoming is too incomplete and too insufficiently described to afford definite information as to what it is.

Among several specimens of Carboniferous quadrupeds received by Professor Cope for study from Mr. R. D. Lacoe, of Pittston, Pa., was a specimen of the earliest known reptile, which was in 1896 first placed by Cope in the species *Tuditanus punctulatus* Cope. Later (1897), however, he removed the form to another genus, *Isodectes*, but retained the same specific term for the form.

Recently, Williston (Journ. Geol., July-August, 1908) has redescribed the specimen and has referred it to another species, which he calls *Isodectes copei* sp. nov. Cope distinctly stated in 1896, and again in 1897, that the form was a true reptile, and as such was the earliest reptile known. His statement seems, however, to have been overlooked, for when Raymond announced the discovery of Carboniferous vertebrates near Pittsburg, Pa., he stated that the forms there discovered were the oldest known reptiles; but Cope's discovery antedated his in two ways—chronologically and geologically. Holland corrected this error in the report of the director of the Carnegie Museum for 1908.

The specimen as preserved is less than six inches long and consists of the entire body of the animal, minus the head and the right fore limb. The absence of the head is to be especially regretted, for it is upon the skull characters that most of our classification is based, and it is to this portion of an animal's anatomy that we refer for the final analysis of the creature's position. The most noteworthy reptilian characters which can be detected on the remains preserved to us are the osseous carpus and tarsus, two sacral vertebræ, the reptilian phalangeal formula (2, 3, 4, 5, 4) for the hind foot, the inter-central attachment of the ribs (as is the case in the Microsauria), and the well ossified condition of the limb bones, a matter of no slight importance. In some of its characters it is so close to the Microsauria that were it not for the two sacral vertebræ and the osseous carpus and tarsus it would undoubtedly find a place among the Amphibia. The absence of ventral ribs is to be especially noted.

The presence or absence of the ventral ribs seems to be a matter which is little understood, and doubt has been thrown on the use of this character as one of any importance. Among the Microsauria there are forms which possess well-developed ventral ribs, and others, not distantly removed otherwise in structure, which possess no ventral ribs whatever, *i. e.*, the Tuditanidæ and the Amphibamidæ. What the function of the ventral ribs was is also a little doubtful. To say that they developed merely to protect the abdomen of the animal is merely begging the question, for if they develop for this purpose in one form why should not other forms with similar habits also develop similar structures? The degree of the ossification of the limb bones is a matter to which but slight attention has been paid. In the study of a large series of the Microsauria this is found to be quite variable. Some forms seem to have the limb bones made up of perichondrium alone,

while others exhibit highly developed endochondrium, and this occurs in forms which we place in the same genus—for instance *Tuditonus punctulatus* Cope and *Tuditonus minimus* Moodie. Just what this may mean remains to be determined. It is possible that it is due to the mode of preservation.

Another form of the greatest interest is the one recently described by the writer from the Mazon Creek beds of Illinois as *Micrerpeton caudatum*. This interesting little fossil is less than two inches in length, but there are preserved in its matrix more characters than we would expect in many specimens of fossil amphibians. The form represents the only species of Branchiosauria so far discovered in North America. On the small nodule in which *Micrerpeton* is embedded there are found a nearly complete outline of the body; a nearly complete skeleton; the black pigment of the eyes; the pigment of skin and the pattern it assumed; minute scales which covered the body; the lateral line canals of the tail, and the ventral scutes—enough, in fact, to warrant a restoration of the animal, and this has been given. (Plate II, fig. 1.)

Another form which will interest us here is the one described in 1865 by Cope under the name of *Amphibamus grandiceps*. This form is known from nearly complete remains which have been described by Dr. O. P. Hay, and again described by the writer with a restoration. The form is interesting as being a typical member of the Microsauria. (Plate III.) It had a short, stumpy tail, a short body, and a short, broad head. It had four toes on the hand and five on the foot, with the phalangeal formula of 2, 2, 3, 2 for the hand and of 2, 2, 3, 4, 3 for the foot. The skeleton of the animal has been restored, with an outline of the body.

Still another form is the one described by Cope as *Molgophis macrurus*, which had neither limbs, ribs nor ventral armature, but consisted merely of a very elongate vertebral column consisting of nearly 100 minute vertebræ and a sharp-pointed skull. This form resembles in great degree the modern whipsnake of Kansas in form and proportions, though it was scarcely ten inches in length.

I have described for you now five forms, which we will try to discuss in the light of our present knowledge in regard to their classification. The first form, *Pelion lyelli* Wyman, is an aberrant form and may be related to the frogs. It has been placed in the Branchiosauria and in the Microsauria. It belongs in neither, but may be placed provisionally in the latter group. The form *Isodecetes copei* Williston has been shown to be a true reptile, and we

need only to say here that its structure is so close to that of some of the Microsauria that the resemblance must be of genetic importance. The *Micrerpeton caudatum* has been proved elsewhere to belong among the Branchiosauria, and this group has been shown to be true amphibians, as we know them to-day. The *Amphibamus* is a true microsaurian, and the *Molgophis* is a side branch of the microsaurians which is known as the *Aistopoda*. Whether the group is entitled to a distinct ordinal rank is open to question. On the basis, then, of the foregoing discussion, we will here propose the following classification for the class Amphibia:

Class AMPHIBIA. Linné, 1758. Devonian to recent.

Subclass I. Euamphibia nom. nov. Carboniferous to recent.

Order 1. Branchiosauria. Credner. Carboniferous.

Order 2. Apoda (Gymnophiona). Muller, 1832. Permian(?) to recent.

Order 3. Caudata. Dumeril, 1806. Permian(?) to recent.

Order 4. Salientia (Anura). Laurenti, 1768. Eocene to recent.

Subclass II. Holospondyli. Schwarz, 1908. Carboniferous and Permian.

Order 1. Microsauria. Dawson, 1863. Carboniferous.

Order 2. Aistopoda. Miall, 1874. Carboniferous.

Order 3. (?)Diplocaulia nom. nov. Permian.

Subclass III. Stegocephala. Cope, 1868. Carboniferous to Upper Triassic (Jurassic?).

Order 1. Temnospondylia. Zittel, 1887.

Suborder 1. Rhachitomi. Cope.

Suborder 2. Embolomeri. Cope.

Order 2. Stereospondylia. Zittel, 1887. Carboniferous to Triassic.

NOTE.—It is doubtful whether the new order, Diplocaulia, belongs in subclass II or subclass III. This will be definitely settled when Williston's results have been made fully known. Full definitions of these new groups will be given in the Kansas University *Science Bulletin* for 1909.

EXPLANATION OF PLATES.

PLATE I.

Photograph of the specimen of *Pelion lyelli* Wyman. This form may be a true ancestor of the modern frogs or it may be an aberrant member of the Microsauria. Times, 1½.

PLATE II.

FIG. 1. *Micrerpeton caudatum* Moodie; a branchiosaurian from the Carboniferous of Illinois.

FIG. 2. *Isodectes copei* Williston; a true reptile from the Carboniferous of Ohio.

FIG. 3. *Tuditonus minimus* Moodie; a microsaurian from the Carboniferous of Pennsylvania.

FIG. 4. *Ptyonius nummifer* Cope; one of the atypical members of the Aistopoda which serve to connect the Aistopoda with the Microsauria. No limbs are present in this form. Carboniferous of Ohio.

FIG. 5. *Tuditonus brevirostris* Cope; a microsaurian from the Carboniferous of Ohio.

PLATE III.

Amphibamus grandiceps Cope; a true microsaurian from the Mazon Creek beds of Illinois. The outline of the body is well exhibited.



PLATE I. Carboniferous fossils.

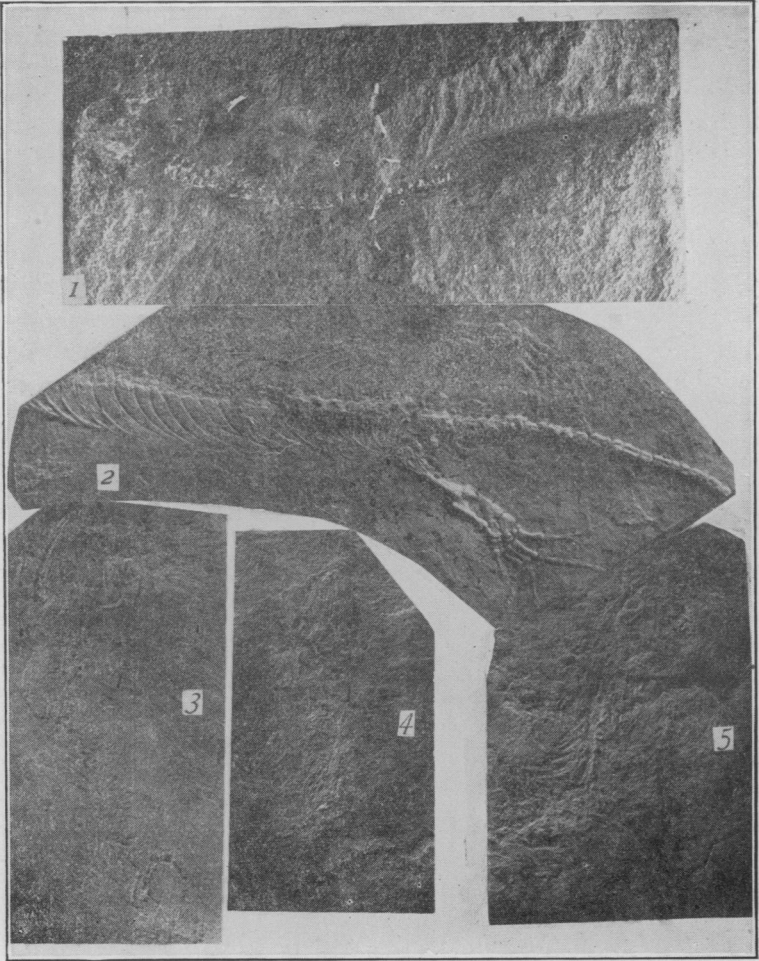


PLATE II. Carboniferous fossils.



PLATE III. Carboniferous fossils.